

## CLAIMS

1. Flexible factory joint for metallic tubes, which enclose loosely inside them optical fibers, comprising:
  - 5 first and second metallic tubes (3, 10) having internal and external diameter, which enclose loosely inside them optical fibers, said optical fibers surrounded by a suitable filling material, separated in one or more bundles (1, 2) and spliced together at their ends, and a connecting metallic tube (6) having an internal and external diameter, said internal diameter being slightly larger than the external diameter of each of the first and second metallic tubes (3, 10), placed in a way such that it encloses the spliced optical fibers and externally overlaps an end section of each of the above first and second metallic tubes (3, 10), and is characterized in that
  - 10 the connecting tube (6) is firmly connected to the first and second metallic tubes (3, 10) at the sections at which it overlaps them, through the creation by plastic deformation of more than one grooved rings (11) which have a diameter smaller than the external diameter of the connecting tube (6).
- 20 2. Flexible factory joint for metallic tubes, which enclose loosely inside them optical fibers, according to claim 1, wherein the diameter, the number and the distance between said grooved rings (11) differ, depending on the type of the material by which said first and second metallic tubes (3, 10) and said connecting metallic tube (6) are made of, so that the required mechanical strength at the connecting points can be achieved.
- 25 3. Flexible factory joint for metallic tubes, which enclose loosely inside them optical fibers, according to claim 1, wherein the ends of the connecting tube (6) are circumferentially externally welded on the of the first and second metallic tubes (3, 10) thus achieving the complete water tightness of the joint.
- 30 4. Flexible factory joint for metallic tubes, which enclose loosely inside them optical fibers, according to any of claims 1 to 3, wherein said first and

second metallic tubes (3, 10) carry a plastic coating (4), which is progressively reduced in thickness and further completely removed towards the connected end of each metallic tube (3, 10).

5        5. Flexible factory joint for metallic tubes, which enclose loosely inside them optical fibers, according to any of claims 1 to 4, wherein the first and second metallic tubes (3, 10) and the connecting tube (6) are enclosed within one or more layers of self amalgamating plastic tape (9) and a heat shrinkable plastic tube, (5) which contribute to the restoration of the plastic coating (4) at the desirable thickness in the area of the joint.

10        6. Flexible factory joint for metallic tubes, which enclose loosely inside them optical fibers, according to any of claims 1 to 5, wherein when said joint is enclosed inside a cable which contains the connected metallic tubes, it is surrounded by successive protective layers in exactly the same way as the said metallic tubes are surrounded in the rest of the cable so that no discontinuity is created between these layers during the manufacture of said cable in the area of the joint, thus ensuring in this area the optical, mechanical and electrical properties of the cable.

20        7. Flexible factory joint for metallic tubes, which enclose loosely inside them optical fibers, according to any of claims 1 to 6, wherein when the joint is enclosed inside a cable, the external diameter of the cable in the area of the joint is the same as in any other part of the cable.

25        8. Method for making a flexible factory joint for metallic tubes, which enclose loosely inside them optical fibers, comprising the following steps:  
a. Providing first and second metallic tubes to be connected (3, 10), having internal and external diameter, said tubes enclosing loosely inside them optical fibers surrounded by a suitable filling material and further providing a connecting metallic tube (6) having an internal and external diameter, said internal diameter being slightly larger than the external diameter of each of the first and second metallic tubes (3, 10),

- b. Positioning temporarily the connecting metallic tube (6) along its whole length over the first metallic tube to be connected (3)
  - c. Cutting out sections at the ends of the metallic tubes to be connected (3, 10) in order to uncover the enclosed optical fibers
- 5       d. Separating the optical fibers in one or more bundles (1,2) each one of them including a maximum number of 12 optical fibers
- e. Cutting each bundle of the fibers at predetermined lengths, depending on the number of the optical fibers enclosed inside the metallic tubes, such that the total length of each bundle after splicing will be the same
- 10      and the total length of two spliced bundles will be shorter than the length of the connecting metallic tube (6)
- f. Splicing the optical fibers following commonly used methods for this purpose
- g. Arranging the metallic tubes to be connected (3, 10) after the splicing of the optical fibers, so that the fibers are horizontally aligned, and subsequently reducing the distance between them at a predetermined length, such that the optical fibers become loose and this way the desirable excess length of the optical fibers is ensured inside the joint.
- 15      h. Applying a filling material over the optical fibers, same as the one surrounding the optical fibers inside the metallic tubes to be connected (3, 10).
- i. Moving the connecting metallic tube (6) over the first metallic tube to be connected (3), the spliced optical fibers (1, 2) and the second metallic tube to be connected (10) so that it overlaps the ends of the metallic tubes to be connected (3, 10) by equal sections.
- 25      j. Securing the stability of the connection through the creation, by plastic deformation, at the sections at which the connecting metallic tube overlaps the metallic tubes (3, 10) to be connected, of more than one grooved rings (11) which have a diameter smaller than the external diameter of the connecting tube (6)
- 30      k. Welding (8) circumferentially the ends of the connecting tube (6) to the external surface of the connected metallic tubes (3, 10) so that complete water tightness of the joint is achieved.

9. Method for making a flexible factory joint for metallic tubes, which enclose loosely inside them optical fibers, according to claim 8, wherein in case the metallic tubes to be connected (3, 10) carry a plastic coating (4), the following preliminary steps precede:

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- a. Removing completely part of the plastic coating (4), at the ends of each one of the metallic tubes to be connected (3, 10)
- b. Gradually reducing in thickness part of the remaining plastic coating (4) towards the ends of the metallic tubes (3, 10) until each metallic tube (3, 10) is completely uncovered and so that the reduced segment of the plastic coating (4) has a conical shape.
- c. Placing temporarily a heat shrinkable plastic tube (5) over the plastic coating (4) of the first metallic tube to be connected (3).

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15 10. Method for making a flexible factory joint for metallic tubes, which enclose loosely inside them optical fibers according to claims 8 and 9, wherein in case the metallic tubes to be connected (3, 10) carry a plastic coating (4), the following final steps follow aiming to the restoration of the plastic coating (4) at the desirable thickness:

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- a. Applying one or more layers of self amalgamating plastic tape (9) over the connected metallic tubes (3, 10) and if required over the connecting metallic tube (6)
- b. Moving the heat shrinkable plastic tube (5) from its temporary position and placing it so that it covers the joint over its whole length
- c. Shrink the above mentioned heat shrinkable plastic tube (5) by heating.

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